Montana Hospital Discharge Data System

Quarterly Surveillance Report

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Carbon Monoxide Morbidity and Mortality in Montana, 2000 - 2008

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The Centers for Disease Control and Prevention recently reported a national six-year average (1999-2004) mortality rate from unintentional, non-fire-related carbon monoxide (CO) poisoning of 1.53 deaths per million population, with a range among states from 0.35 to 6.19 per million.[1] Deaths peaked in January and were more common among men than women (3:1). Very few deaths occurred among children under the age of 15 and deaths increased across ten-year age groups, from 1.06 per million among those age 15 to 24 years to 2.13 among those age 65 years and older.

Montana, along with Alaska, Nebraska, North Dakota, and Wyoming had mortality rates substantially higher than the national average (4.16, 4.32, 4.88, 3.20, and 6.19 respectively). These states have in common harsh winter weather and rural or frontier status and may share risk factors for CO exposure, including poorly maintained or improperly vented furnaces and water heaters; tightly sealed houses; use of gas-powered generators and combustion heat sources during power outages, as supplemental heat, or in outbuildings; and prolonged warming up of vehicles in garages or near building air intakes.

Mortality does not capture the full burden of CO poisoning. Nationally, there are approximately 30 Emergency Department (ED) visits for CO poisoning for each death.[2] In the absence of ED data, hospital discharge data can provide an estimate of the magnitude of non-fatal CO poisoning, although this will be an undercount because only the most serious cases are hospitalized. There may be as many as 10 to 15 ED visits for each admission for CO poisoning, although systematic data about this are limited.[3]

The Montana Hospital Discharge Data System (MHDDS) receives annual de-identified hospital discharge data sets through a Memorandum of Agreement with the Montana Hospital Association.[4] Most hospitals in Montana participate in voluntary reporting of discharge data from Uniform Billing forms, version 2004 (UB-04).[5] The MHDDS receives information on more than 90% of the inpatient admissions from non-psychiatric facilities in the state. It does not receive data on ED visits or outpatient procedures at this time. Data sets are currently available for discharge years 2000 through 2008.

By law, Montana death certificates must include the underlying cause of death and, if death resulted from an injury, the intent and circumstances of the death. Death certificates include a section for the causal and chronological sequence of events leading to death to be completed by an attending physician or coroner, using the international *Statistical Classification of Diseases, Injuries, and Related Health Problems,* 10th

[1] Centers for Disease Control and Prevention, 2007. Carbon monoxide-related deaths, United States, 1999-2004. *MMWR* 56:1309-1312.
[2] Centers for Disease Control and Prevention, 2005. Unintentional non-fire-related carbon monoxide exposures in the United States. *MMWR* 54:36-39.
[3] http://ephtracking.cdc.gov/showQueryScreen.action
[4] http://www.dphhs.mt.gov/PHSD/MT-HDDS/MTHDDS-index.shtml
[5] http://www.shepscenter.unc.edu/research_programs/hosp_discharge/links/ub04_fact_sheet.pdf

revision (ICD-10).[6] Montana death certificates therefore have excellent ascertainment of intent and may have substantial detail about circumstances.

Hospital discharge data have the potential to report intent and circumstances of injuries through the Supplemental Classification of External Causes of Injury and Poisoning (E-codes), which are required for most admissions with an injury diagnosis.[7] There should be an E-code for mechanism and one for location or other circumstance for each injury. E-coding is incomplete in the MHDDS: only 43% of primary diagnoses and 50% of secondary diagnoses for CO poisoning in 2000 through 2008 had E-codes.

Because of the incomplete E-coding, we included all hospital discharges with CO poisoning as a primary or secondary diagnosis (ICD-9-CM[8] code 986) in our analysis, regardless of recorded intent or association with fire. Where possible, we distinguished suicide attempts (identified by E-code) from those of unknown intent and admissions involving fire (identified either from E-codes indicating fire or from diagnostic codes indicating concomitant burns or smoke inhalation) from other causes.

Montana's annual average mortality rate for presumably unintentional, non-fire-related CO poisoning in 2000-2008 was 3.94 per million, similar to the rate of 4.16 reported by the CDC for Montana in 1999-2004.[9] The mortality rate for *all* CO poisoning mortality in Montana for 2000-2008 was 19.24 per million.

Men were almost twice as likely as women to be hospitalized for CO poisoning and three times more likely to die (Table 1). Approximately two thirds of both hospitalizations and deaths occurred among adults age 25 to 64 years and approximately one fifth among those age 65 years and older. There was a strong seasonality in hospitalizations, with a peak in the coldest months (December through February) and a deficit in the hottest months (June through August).

Nearly 20% of hospitalizations for CO poisoning were identified by E-codes as suicide attempts. This is certainly an under-ascertainment because of the frequency of missing E-codes in the MHDDS as well as the fact that many patients would have been treated in an ED and discharged. Only two patients admitted with CO poisoning died; neither was classified as a suicide attempt by E-code. In contrast, more than half of the CO deaths in the Office of Vital Statistics (OVS) death records were classified as suicides. Most CO suicide deaths (66 of 70) did not occur in hospitals, but were discovered dead on scene or died en route. CO accounted for 0.2% of all deaths but for 5.8% of all suicide deaths in Montana between 2000 and 2008. Firearms account for approximately two thirds of completed suicides in Montana.

The male preponderance in CO poisoning in the MHDDS was stronger among identified suicide attempts than among poisonings of unknown intent (Table 2). Identified suicide attempts were noticeably most common among adults age 25 to 64 years old and showed no seasonality. In contrast, CO poisoning hospital discharges of unknown intent were strongly seasonal. Although the majority of cases of unknown intent were age 25 to 64 years, a quarter of the patients were age 65 years and older, compared to only 2% of identified suicide attempts.

Although the small number of discharge or mortality events associated with CO poisoning make it impossible to compute reliable rates, the percentage distribution of events is useful for identifying segments of the population at greatest risk, such as adults age 25-64 in general and for suicide prevention in particular, adults age 65 and older for unintentional CO poisonings, and the winter months for awareness campaigns.

[6] http://apps.who.int/classifications/apps/icd/icd10online/
[7] http://www.health.state.ny.us/statistics/sparcs/sysdoc/appn.htm
[8] http://icd9cm.chrisendres.com/
[9] Access to mortality data was provided courtesy of the Montana Office of Vital Statistics; analysis of these data was conducted by MHDDS staff.

Table 1. Carbon Monoxide Poisoning Hospital Discharges and Deaths in Montana, 2000-2008

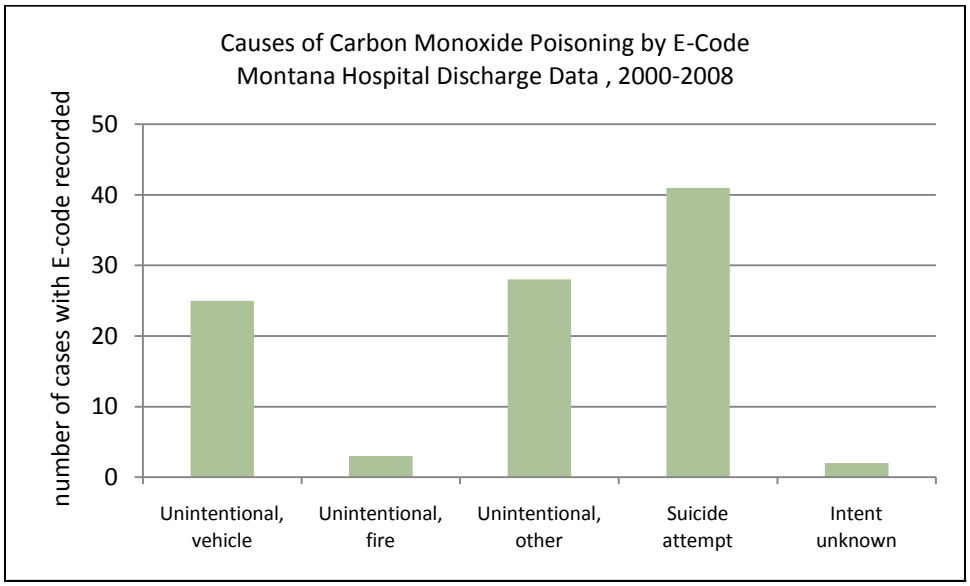
	MHDDS Discharges		OVS Deaths[10]	
	Number	Percent	Number	Percent
Total	217	100.0	161	100.0
Male	141	65.0	123	76.4
Female	76	35.0	38	23.6
0-14 years	3	1.4	6	2.7
15-24 years	23	10.6	8	5.0
25-64 years	144	66.4	114	70.8
65+ years	47	21.7	33	20.5
December-February	77	35.5	40	24.8
March-May	55	25.3	43	26.7
June-August	38	17.5	31	19.3
September-November	47	21.7	47	29.2
Suicide or attempt	43	19.8	93	57.8
Fire-related	3	1.4	27	17.4
Unintentional or unknown	171	78.8	41	25.4

Table 2. Carbon Monoxide Poisoning Hospital Discharges by Intent in Montana, 2000-2008

	Suicide Attempts		Unknown Intent§	
	Number	Percent	Number	Percent
Total	43	100	174	100
Male	32	74.4	109	62.6
Female	11	25.6	65	37.4
0-14 years	0	0	3	1.7
15-24 years	5	11.6	18	10.3
25-64 years	37	86.0	107	61.5
65+ years	1	2.3	46	26.4
December-February	11	25.6	66	37.9
March-May	11	25.6	44	25.3
June-August	11	25.6	27	15.5
September-November	10	23.3	37	21.3
§Includes events associated with fire but not identified as suicide attempts				

[10] Access to mortality data was provided courtesy of the Montana Office of Vital Statistics; analysis of these data was conducted by MHDDS staff.

In examining the discharges with CO poisoning that have E-codes -- approximately half the cases -- it appears that nearly half of the unintentional cases involved motor vehicle exhaust, very few involved fire, and more than half were determined to be unintentional but no further information about cause was available.



CONCLUSIONS

CO poisoning is a relatively uncommon cause of hospitalization in Montana, accounting for a fraction of 1% of all discharges. This is certainly an underassessment of the health burden of CO poisoning because it does not include patients treated on-scene by emergency responders or patients treated in Emergency Departments and released without admission.

Among CO poisonings of unintentional or unknown intent, the male preponderance and age distribution suggests that many might be associated with occupational exposures. The fact that more than one quarter of the unintentional CO poisonings occurred to adults age 65 years and older, and the preponderance in cold months, suggests that many may also be associated with faulty home heating devices or dangerous practices. Unfortunately, the combination of relatively small numbers of cases, absence of Emergency Department data, and absence of E-codes makes it impossible to explore these hypotheses further.

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Please visit our website at http://www.dphhs.mt.gov/PHSD/MT-HDDS/MTHDDS-index.shtml